PCT/IB04/052653.

Sertifikaat

REPUBLIEK VAN SUID AFRIKA

PATENT KANTOOR
DEPARTEMENT VAN HANDEL
EN NYWERHEID

Certificate

REPUBLIC OF SOUTH AFRICA

PATENT OFFICE
DEPARTMENT OF TRADE AND
INDUSTRY

Hiermee word gesertifiseer dat
This is to certify that

1) South African Provisional Patent Application No. **2003/9462** accompanied by a Provisional Specification was originally filed at the South African Patent Office on **5 December 2003** in the name of **UNIVERSITY OF PRETORIA** in respect of an invention entitled: **METHOD AND APPARATUS FOR MONITORING BIO-FILM FORMATION.**

2) The photocopy attached hereto is a true copy of the provisional specification and drawings filed with South African Patent Application No. **2003/9462**.

Geteken te **PRETORIA** in die Republiek van Suid-Afrika, hierdie **12th** dag van **January 2005**

at in the Republic of South Africa, this day of

.....
Registrar of Patents

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

Form P.2

REPUBLIC OF SOUTH AFRICA

PATENTS ACT, 1978

REGISTER OF PATENTS

OFFICIAL APPLICATION NO.	LODGING DATE : PROVISIONAL	ACCEPTANCE DATE
21 81 2003/9462	22 5 December 2003	43
INTERNATIONAL CLASSIFICATION	LODGING DATE : COMPLETE	GRANTED DATE
51	23	

FULL NAME(S) OF APPLICANT(S) / PATENTEE(S)

71 UNIVERSITY OF PRETORIA

APPLICANTS SUBSTITUTED :	DATE REGISTERED
71	

ASSIGNEE(S)	DATE REGISTERED
71	

FULL NAME(S) OF INVENTOR(S)

72 CLOETE, Thomas Eugene

VAN VUUREN, Stefanus Johannes

PRIORITY CLAIMED	COUNTRY	NUMBER	DATE
N.B. Use international abbreviation for country. (See Schedule 4)	33	31	32

TITLE OF INVENTION

54 METHOD AND APPARATUS FOR MONITORING BIOFILM FORMATION

ADDRESS OF APPLICANT(S) / PATENTEE(S)

Cnr. Lynnwood & University Roads
Hatfield
Pretoria
South Africa

ADDRESS FOR SERVICE	REF
74 D M Kisch Inc, 54 Wierda Road West, Wierda Valley, SANDTON	P27839ZAPO

PATENT OF ADDITION NO.	DATE OF ANY CHANGE
61	
FRESH APPLICATION BASED ON	DATE OF ANY CHANGE

Form P.1

REPUBLIC OF SOUTH AFRICA
PATENTS ACT, 1978

REVENUE PAID -5.12.03 PRETORIA BEDRAG

REPUBLIEK VAN SUID-AFRIKA R 60.00 PO NR 229

Form P.1

APPLICATION FOR A PATENT AND ACKNOWLEDGEMENT OF RECEIPT

(Section 30 (1) - Regulation 22)

The grant of a patent is hereby requested by the undermentioned applicant on the basis of the present application filed in duplicate.

OFFICIAL APPLICATION NO		
21	01	2003/9462

DMK REFERENCE
P27839ZAPO

Public.
Patent
2003\09462

FULL NAME(S) OF APPLICANT(S)

71 UNIVERSITY OF PRETORIA

ADDRESS(ES) OF APPLICANT(S)

Cnr. Lynnwood & University Roads
Hatfield
Pretoria
South Africa

TITLE OF INVENTION

54 METHOD AND APPARATUS FOR MONITORING BIOFILM FORMATION

THE APPLICANT CLAIMS PRIORITY AS SET OUT ON THE ACCOMPANING FORM P2
The earliest priority claimed is

THIS APPLICATION IS FOR A PATENT OF ADDITION TO PATENT APPLICATION NO.	21	01	
THIS APPLICATION IS FRESH APPLICATION IN TERMS OF SECTION 37 AND BASED ON APPLICATION NO.	21	01	

THIS APPLICATION IS ACCOMPANIED BY :

x	1a	A single copy of a provisional specification of 11 pages.
	1b	Two copies of a complete specification of pages.
	2a	Informal drawings of sheets.
x	2b	Formal drawings of 2 sheets.
	3	Publication particulars and abstract (form P8 in duplicate).
	4	A copy of figure of the drawings for the abstract.
	5	Assignment of invention (from the inventors) or other evidence of title.
	6	Certified priority document(s).
	7	Translation of priority document(s).
	8	Assignment of priority rights.
	9	A copy of form P2 and a specification of S.A. Patent Application.
	10	A declaration and power of attorney on form P3.
	11	Request for ante-dating on form P4.
	12	Request for classification on form P9.
	13a	Request for delay of acceptance on form P4.
	13b	

21	01	

DATED 5 December 2003

Patent Attorney for Applicant(s)

REGISTRAR OF PATENTS, DESIGNS, TRADE MARKS AND COPYRIGHT
RECEIVED
OFFICIAL DATE STAMP
2003 -12- 05
REGISTRAR OF PATENTS
REGISTRATEUR VAN PATENTE, MODELLE, HANDELSMERKE EN OUTEURSREG

ADDRESS FOR SERVICE

74 D M Kisch Inc
Inanda Greens Business Park
54 Wierda Road West
Wierda Valley
SANDTON

The duplicate will be returned to the applicant's address for service as proof of lodging but is not valid unless endorsed with official stamp.

D. M. Kisch Inc, Sandton

Form P.6

REPUBLIC OF SOUTH AFRICA

PATENTS ACT, 1978

PROVISIONAL SPECIFICATION
(Section 30 (1) - Regulation 27)

OFFICIAL APPLICATION NO.			LODGING DATE		DMK REFERENCE
21	01	2003/9462	22	5 December 2003	P27839ZAPO

FULL NAME(S) OF APPLICANT(S)	
71	UNIVERSITY OF PRETORIA

FULL NAME(S) OF INVENTOR(S)	
72	CLOETE, Thomas Eugene VAN VUUREN, Stefanus Johannes

TITLE OF INVENTION	
54	METHOD AND APPARATUS FOR MONITORING BIOFILM FORMATION

METHOD AND APPARATUS FOR MONITORING BIOFILM FORMATION

INTRODUCTION

This invention relates to a method and apparatus for monitoring biofilm formation.

BACKGROUND TO THE INVENTION

In this specification, the term "biofilm" means microorganisms accumulated or formed on a surface. The impact of biofilm formation varies in different technical systems, thus, they can tolerate biofilms to a lesser or greater extent until an interference of process or product quality is observed. In order to keep biofilm growth below a certain "threshold of interference", it is necessary to obtain information about the actual extent of biofilm formation for timely and effective countermeasures. Such a "threshold of interference" varies according to the demands of a given process. Known monitoring devices for monitoring biofilm formation on surfaces include fibre optic devices and infrared monitors. (*Melo, L. F., Flemming, H-C., Cloete, T. E. (2003), IWA Publishing. "Water Science & Technology, Biofilm Monitoring" pp1-8, 19-24, 39-43.*)

A known fibre optic device consists of a sending fibre and a receiving fibre, both penetrating a wall of a water pipe with the tips of the fibres even to the inner pipe surface. By using the intensity of backscattered light for assessing the thickness of the deposit, which has accumulated on the tip of the fibre, biofilm

formation on the tips of the fibres is detected. The receiving fibre collects the signal and forwards it to a detection and quantification unit. A disadvantage of this device is that, since the tips of the optical fibres are relatively very small, there is only a small surface on which biofilm accumulates. The measurements taken are therefore not representative of biofilm formation in a complete system.

A known infrared monitor is used for detecting biofilm formation on a surface in a flowing system, consisting of a pipe through which water flows. The pipe has transparent glass walls, which provides the surface for biofilm accumulation. An infrared transmitter is located on one side of the pipe and an infrared receiver is located on an opposite side of the pipe. Radiation from the transmitter to the receiver passes through both glass walls of the pipe; the biofilm accumulated on the glass surface; and the water passing through the pipe. The difference between the radiation emitted and that received is the amount absorbed by the system. The amount of infrared radiation absorbed by the biofilm is proportional to the amount of biofilm present on the surface.

A disadvantage of this system is that the difference between the radiation emitted and that received is the amount of radiation absorbed by the system and not only radiation absorbed by the biofilm formed on the surface. Thus, as properties of the water varies, the amount of radiation absorbed by the water

also varies and therefore does not produce accurate results regarding the amount of biofilm formation.

OBJECT OF THE INVENTION

It is therefore an object of the present invention to provide a method and apparatus for monitoring biofilm formation with which the aforesaid disadvantages can be overcome or at least minimised.

SUMMARY OF THE INVENTION

According to a first aspect of the invention there is provided apparatus for monitoring biofilm formation on a surface comprising:

- a member providing said surface for continuously moving into and out of a body of liquid; and
- a sensor for measuring biofilm formation and for being located outside the body of liquid and for measuring biofilm formation on a measuring zone of the surface disposed outside the body of liquid.

The member may be a disk and may rotate about a central axis.

The member may be located inside a housing.

The housing may be provided with a liquid inlet and a liquid outlet and a passage for the liquid extending through the housing from the inlet to the outlet.

The liquid may fill the housing only partly, the arrangement being such that as the member continuously rotates in the housing, at any given time a portion thereof is submerged in the liquid and another portion, providing the said measuring zone, is disposed outside the liquid.

The disk may include a central axle about which it rotates.

The sensor may be disposed inside the housing above the level of the liquid, in use.

The sensor may include a transmitter for transmitting a light beam onto said measuring zone and a receiver for receiving light reflected from the surface.

Alternatively the disk may be transparent and the transmitter and the receiver may be located on opposite sides of the disk, the arrangement being such that the transmitter transmits a light beam onto said measuring zone and the receiver receives the light passing through the surface.

The transmitter may transmit infrared radiation or a beam of light, such as green light.

The sensor may be adapted to send a signal representing the amount of reflected light to a processor for determining the amount of biofilm formation on the surface, the amount of reflected/received light being proportional to the extent of biofilm formation on the surface.

A plurality of bodies of different material may be mounted along the outer periphery of the disk, the arrangement being such that biofilm formation on different materials can be observed.

The bodies extending from the disk may further aid rotation of the member about its central axis, whilst the liquid flows from the inlet to the outlet along the passage.

The apparatus may include a pump for pumping liquid into the housing via the inlet.

The body of liquid may be water, but the apparatus could be used to monitor biofilm formation in any liquid prone thereto.

According to a second aspect of the invention there is provided a method for monitoring biofilm formation on a surface including the steps of:

- providing a body of liquid;

- providing a member providing a surface having a measuring zone disposed outside the body of liquid;
- continuously moving the surface into and out of the body of liquid;
- providing a sensor for measuring biofilm formation outside the body of liquid; and
- measuring biofilm formation by measuring light being received from the said measuring zone.

The step of continuously moving the surface into and out of the body of liquid may include the step of rotating the member about a central axis, the arrangement being such that a portion thereof is submerged in the liquid and another portion is outside the liquid.

The step of measuring biofilm formation on the surface includes the further steps of transmitting a light beam onto said measuring zone; and receiving the light beam being reflected from the surface.

Alternatively, the step of measuring biofilm formation on the surface includes the further steps of transmitting a light beam onto said measuring zone; and receiving the light beam passing through the surface, the surface being transparent.

The method may include the step of processing a signal representing the amount of reflected/received light, for determining the amount of biofilm formation on the surface, the amount of reflected light being proportional to the extent of biofilm formation on the surface.

The method may include the further step of observing biofilm formation on different types of materials.

The step of observing biofilm formation on different types of materials may include the steps of providing bodies of different types of materials, connecting the bodies to the member so that they are rotated with it, intermittently removing said bodies and observing said biofilm accumulation thereon.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described further by way of a non-limiting example with reference to the accompanying drawings wherein:

figure 1 is a perspective view of an apparatus according to a preferred embodiment of the invention for monitoring biofilm formation, with a housing being open to show a member providing a surface on which the biofilm forms; and

figure 2 is the same as figure 1 with the housing closed and showing a sensor for monitoring the biofilm formation on the surface.

DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Referring to the drawings, an apparatus for monitoring biofilm formation according to a preferred embodiment of the invention is generally designated by reference numeral 10.

The apparatus 10 for monitoring biofilm formation on a surface 12 comprises a disk-shaped member 14 which provides said surface 12; and a sensor 16 for measuring biofilm formation on a measuring zone 18 of the surface 12.

A plurality of bodies, such as plates 20 are mounted along the outer periphery of the disk-shaped member 14. The plates 20 are of different materials so that biofilm formation on different materials can be observed.

The apparatus 10 includes a housing 22 wherein the member 14 is located. A body of liquid 24, such as water, is disposed inside the housing 22 and fills the housing 22 only partly. The housing 22 has a liquid inlet 26 and a liquid outlet 28 and a passage for the liquid extending through the housing 22 from the inlet 26 to the outlet 28.

The member 14 is continuously moved into and out of the liquid 24 by being rotated about its central axle 30. At any given time, a portion of the member 14 is therefore submerged in the liquid 24 and another portion, providing the said measuring zone 18, is disposed outside the liquid 24.

Rotation of the member 14 is further facilitated by a water pump 32, which pumps the liquid 24 into the housing 22; and the plates 20 extending from the member 14 aiding in propulsion thereof whilst the liquid 24 flows from the inlet 26 to the outlet 28 along the passage.

The sensor 16 is located inside the housing 22 above the level of the liquid 24. The sensor 16 includes a transmitter and a receiver (both not shown). The transmitter transmits green light onto the surface 12.

In use, as liquid 24 is pumped into the housing 22 via the inlet 26, through the passage and out of the housing 22 via the outlet 28, the member 14 is rotated about its central axle 30 as shown by arrow A in figure 1. Rotation of the member 14 continuously moves the member 14 into and out of the liquid 24, the arrangement being such that biofilm formation on the surface 12 can be measured at the measuring zone 18. The transmitter transmits a green light beam onto said measuring zone 18 and the receiver receives the beam of light being reflected from the surface 12. The sensor 16 sends a signal, which represents the amount of reflected light to a processor (not shown) for determining the amount of biofilm formation on the surface 12, the amount of reflected light being proportional to the amount of biofilm formed on the surface 12. Biofilm also forms on the plates 20 of different materials. By intermittently

removing said plates 20 from the member 14, biofilm accumulation on different materials can be observed.

It will be appreciated that the apparatus 10 provides real time monitoring of biofilm formation on the surface 12. It will further be appreciated that biofilm formation on different materials can be observed by using plates 20 of different materials and intermittently removing said plates 20 to monitor biofilm accumulation thereon. The apparatus 10 can be connected to an existing system and as the liquid 24 continuously passes through the apparatus 10, accurate measurements of biofilm formation, representing the entire system, is obtained.

It will also be appreciated that variations in detail are possible with a method and apparatus for monitoring biofilm formation according to the invention without departing from the scope of this disclosure. For example, the disk may be transparent and the transmitter and the receiver may be located on opposite sides of the disk, the arrangement being such that the transmitter transmits a light beam onto said measuring zone and the receiver receives the light passing through the surface. The received light is proportional to the amount of biofilm formed on the surface.

Dated this 5 day of December 2003

Patent Attorney / Agent for the Applicant

UNIVERSITY OF PRETORIA

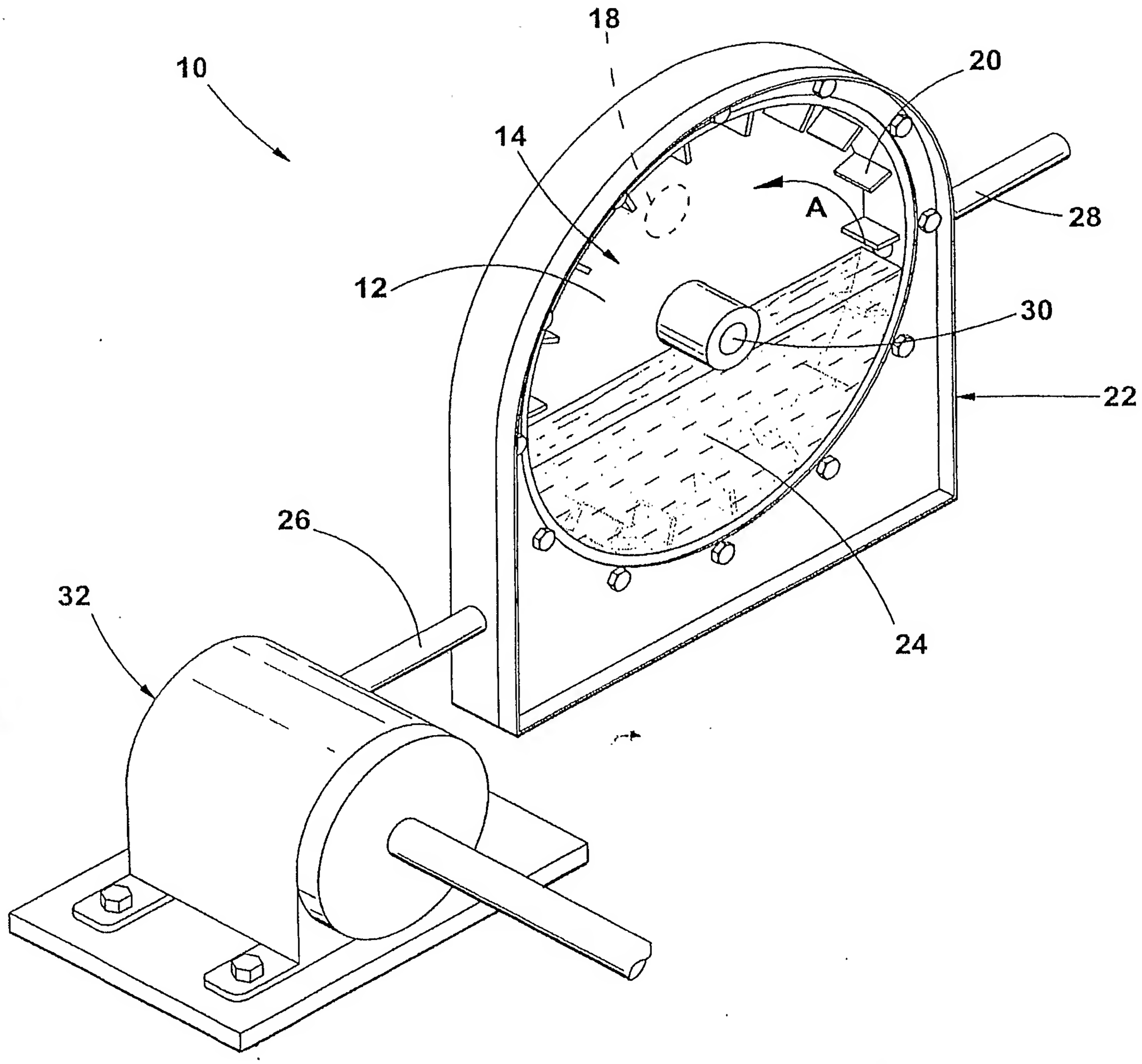

FIGURE 1

D.M. KISCH INC.

PATENT ATTORNEY FOR THE APPLICANT

UNIVERSITY OF PRETORIA

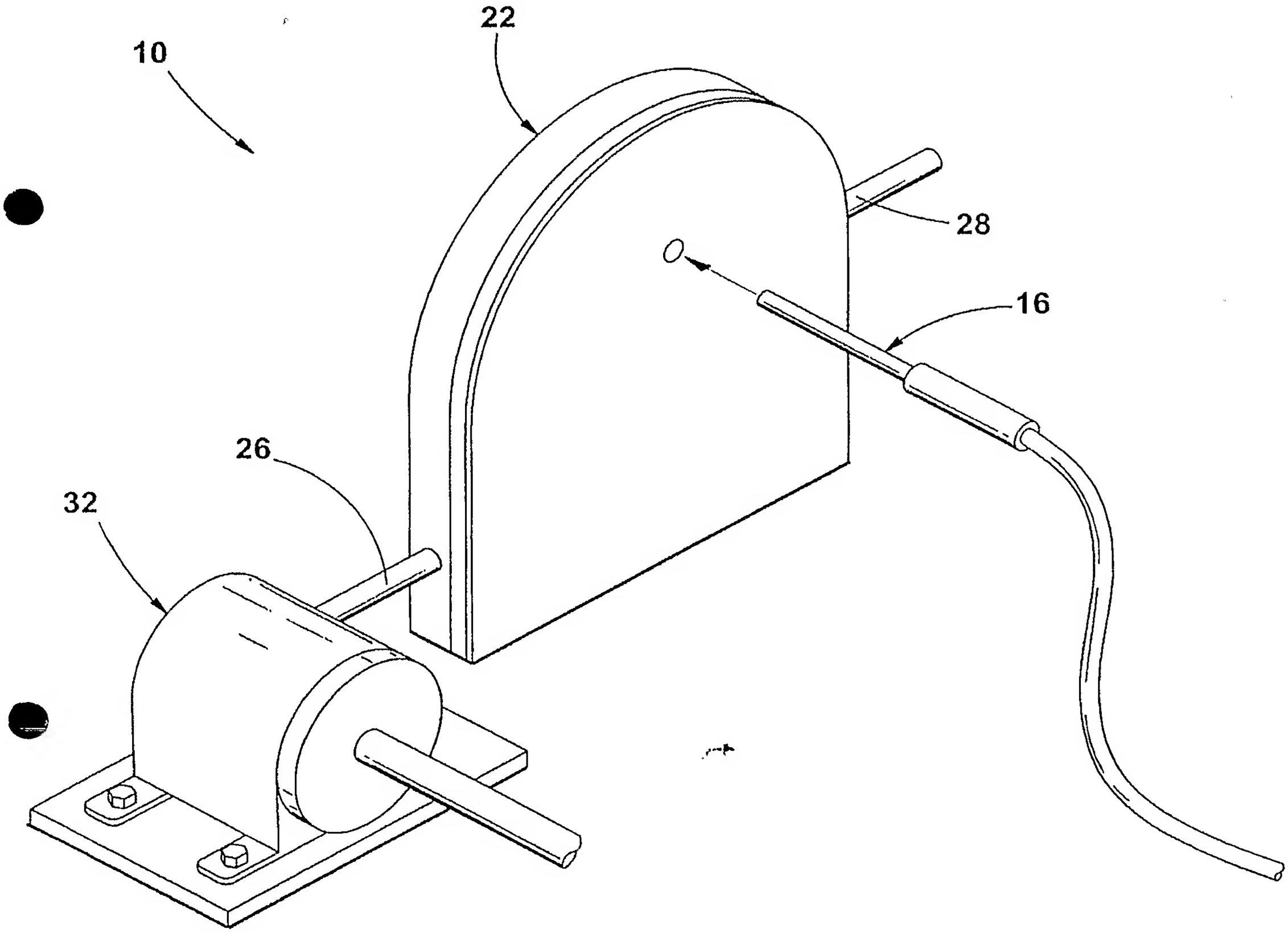

FIGURE 2

D.M. KISCH INC.

PATENT ATTORNEY FOR THE APPLICANT